Project Proposal for 533

VisCap: A Tool for Visualization of Chinese Ancient Capitals

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1. Description of the domain, task, and dataset

China is well-known for its long national history. Different from western countries whose power of the kingdom was shared by the king and the nobles, almost all the aspects of the Chinese society, like politics, economics, education and culture were deeply controlled and influenced by the central government. Even when the whole country was split up into several small kingdoms that fought against each other, all hoping to unite the whole nation, the capitals of these kingdoms became regional centers, which are able to exert impact on the rest the territory they governed.

Because of this characteristic of centralization, it is interesting to analyze which cities were more likely to become the capital of the empire, while which were winners when the country was split up. Besides information like how many dynasties chose a certain city as their capital or how many years this city has been a capital, it is also important to obtain the pattern how the capital (thus the center) of the country moved from one region to another over thousands of years, and to link this pattern to various historical facts, which will help users better understand the history of China. The potential users will include not only professionals in this domains, but also general public who want to obtain a basic understanding of Chinese history.

The dataset to be visualized derives from the one in Wikipedia[1]. This decision involves several considerations. First, unlike professional articles or books that talking about details of when, where and how each dynasty chose cities as their capitals, this link gives a quick and concise summary of the target data. Second, dataset available on the web is always more easily accessible, allowing more users to use the application while still enabling them to refer to the traditional static tabular version for comparison or for details which is not available in the application for several reasons that are omitted here for the continuity of the contents. Third, because history itself is objective and controversial, some of the original data is omitted or changed so that visualization can be carried out. However, by using this dataset, we hope that to the largest degree in the future, we can always keep the dataset up-to-date by simply referring to the edit record of this web page, once historical evidence are available.

2. Personal expertise

The reason why we choose this topic as our course project is that both of us are very interested in history and have been thinking about how to make it easier for professionals as well as general public to understand Chinese ancient capitals, or more broadly, Chinese history, which ranges for thousands of years and includes so many dynasties that it is extremely easy to get confused by their names, orders and their capitals. At least one of us has been to Beijing, Nanjing and Hangzhou, which are among the greatest ancient capitals of China. During travelling it is interesting to think about what it means to this region or the whole nation that the capital of China is moved from one place to another (e.g. year 229AD Wu Kingdom set Nanjing (Called Jianye at that time) as its capital, which started the period when the center of China moves from north to south and a vast prosperity in economics and culture in south part of China is witnessed). Given no application is available which

visualizes Chinese ancient capitals to our best knowledge, we really hope in the long run this project can serve more than just a project of this course.

3. Description of infovis solution

3.1 Task abstraction

Currently, we summarize the following tasks that will probably be performed by the above users with different Give a system, users are able to:

1). view geographical distribution of capitals on a map given a time point or a time period;
2). obtain detailed information about each capital like dynasty, ethnic group, scope (national or regional), and its existing period, etc;
3). detect relationships among different capitals belong different kingdoms (conquest, succession) and the same kingdom (moving the capital);
4). given time, ethnic and scope filter, compare different cities as to number of dynasties that chose it as their capitals, the time range it was a capital and its distribution pattern;
5). get a detailed view when the information interested is regional or provincial;
6). compare distribution patterns of "centralization" of different time period, such as density, geographical scope, majorly covered area, etc;
7). measure the frequency of a dynasty's moving its capital, and view the trends;
8). decide whether the information is displayed adaptive to data density or not, when the time range of a capital is smaller than commonly used granularity;
9). given a city and various filters (time, ethnic and scope), display the nearby capitals with level of "nearby" specified by the user;
10). given above filters, display the capitals in a certain region or province.

3.2 Data abstraction

Having analyzed the dataset and taking into all the possible situations into account, now we can talk about what is the actual data to be visualized. Simply put, the following attributes will be considered. We classify them into several categories of data type based on their properties, and show the category each attribute belongs to.

1) Identifier that uniquely represents a kingdom; (Identifier)
2) Name of the kingdom (a kingdom may have different names in different time period); (Kindom)
3) Name of the capital (the capital of a kingdom may have different names in different time period even if the location of the capital didn't change); (Capital)
4) Location of the capital, including latitude and longitude; (Location)
5) The province the capital belongs to today; (Province)
6) Ethnic group of the governor who established the kingdom; (Ethnic group)
7) Scope of the kingdom, whether it is national or regional; (Scope)
8) The conqueror kingdom; (Relation)
9) The ancestor kingdom (a kingdom may be replaced by another one while the governors of the two kingdoms are related by blood; or a kingdom may split up into several small ones whose governors are closely (possibly by consanguinity) related, while each claims legal inheritance of their common ancestor kingdom); (Relation)

10) Time period, including the start time and the end time. (Time period)
11) Level of influence to the whole kingdom as a capital. (Influence)

3.3 Visual encoding

The following visual encoding will be associated with each data type respectively.

Identifier
Since Identifier is used by system to organize data, it will not be displayed.

Kingdom
Color will be used to represent different kingdoms.

Capital
Capital will be labeled using plain text. Name can be displayed on the map, or as widget options in the panel.

Location
Location includes longitude and latitude, both of which are quantitative data. The longitude and latitude are directly mapped to the coordinates of the capitals on the map displayed. (If a capital is represented by a circle, then the location of its center will be specified by Location).

Province
When the task related to province starts, color will be used to highlight the selected province on the map.

Ethnic group
Texture is considered in current stage for distinguishing Ethnic group. In order to show the ethnic mixture, texture-like symbol will become a good conjecture.

Scope
Categorical data type Scope will be encoded with a ring. National capital is surrounded with a ring but regional capital does not.

Relation
Two types of relation, conquering and descendant are considered. If kingdom A conquers kingdom B, the symbol of B will be painted with the same color as A, and will disappear gradually. If two kingdoms, C and D, are descendants of A, the interior part of their symbol's color will inherit from that of kingdom A. Besides, new colors will be used to represent the exterior part of C and D to tell them apart.

Time period
Time slider is always provided for user to choose either a time point or a time period. Two pointers, along with calibration are associated with a time slider.

Influence

Currently, the influence of a capital is simply calculated based on how long this capital existed. Area will be used to encode influence. The symbol's area increase as the time goes by.

3.4 Interactive Techniques

3.4.1 Animation

In many cases, animation is used to convey visual information. The basic animation should be the city varying along the time line. The capital city of one kingdom might migrate frequently and form a moving track, we should be able to show the process of that moving and record the final route. As time varying, the kingdom will become stronger and stronger, thus we need to expand the size of city symbol to mimic that developing effect. When showing the relation, namely conquering and descendent, we need to implement a sort of ray effect, which starts from who initiates it to who respond. For instance, if conquering happened, there will be a ray effect shot from the conqueror to the conquered kingdom, which could give a good illusion for users to understand what has happened. For descendent case, ancestor will launch several beams to the descendent, showing that all the descendent were belong to the ancestor before the inheritance.

3.4.2 Interaction

The first straight forward interactive technique we concerned is time slider controlling. There are two pins on the slider, representing the starting and the ending time separately. If animation of the time-varying isn't executed, the left (start) pin could help you to pick a static time (maybe a specific year) to see certain patterns from the map. After the start and end pin have been confirmed, user could acquire an animating view showing the changes of kingdom property along with time varying.

We are also going to implement a function of selecting geographical region. The selected region will filter out those capitals in some wanted areas on the map. Those selected capital cities are candidates for a panel to show that in what time appeared some capitals and how many cities were build in these places. To choose such a region, users could drag a rectangle or move a circle with given radius to where they are interested in by moving their mouse.

Another interaction involved is a parallel coordinate panel. This panel wants to display each kingdom by parallel displaying the attributes and have lines connected between each two adjacent attribute lines. The leftmost coordinate could be the time axis. The function of zoom-in/out for each coordinate alone should be implemented. It seems that our data number is very small, compared with huge data visualization, so that we don't need that zoom function, however, many historical events might concentrate on some special time and make it hard for users to see clearly what happened in that period. Thus, in that case, zooming in/out will provide users with great flexibility to explore any concentrative attributes. As non-nearby attribute lines have few things to figure out, we assume that any two neighboring lines could be exchanged to each other, which makes it possible for users to inspect and compare

between any two attribute lines. Users can drag any attribute line to the either side neighbor, by doing that users can easily exchange two attribute lines and see the new result. Of course, we can also filter out some specific data by sliding one any of the attribute lines.

4. Scenarios of use

A scenario spells out what a user would have to do and what he or she would see step-by-step in performing a task using a given system. The key distinction between a scenario and a task is that a scenario is design-specific, in that it shows how a task would be performed if you adopt a particular design, while the task itself is design-independent: it's something the user wants to do regardless of what design is chosen.

Allen is a second-year social science student who is trying to write a course essay about comparison between political patterns of two eastern countries: India and China - regarding to the effects of locations of capitals - before 1600 A.D., when the British established East India Company. However, Allen is not so familiar with Chinese history, he then turns to VisCap for help in order to have a general picture of the political pattern in ancient China around the Song dynasty.

What he is looking for is a fast yet effective method that enables him to discover basic information like dynasties, theirs capitals and locations in different time period. Also it is important for him to discover potential relationships between different kingdoms. In some special cases, he is interested in how a kingdom chooses cities when moving a capital is a must. Of course, it will be good if the more valuable description of patterns of capital distributions can be displayed so that he is able to analyze the relationship between political pattern and other potential social environmental change in a certain time period.

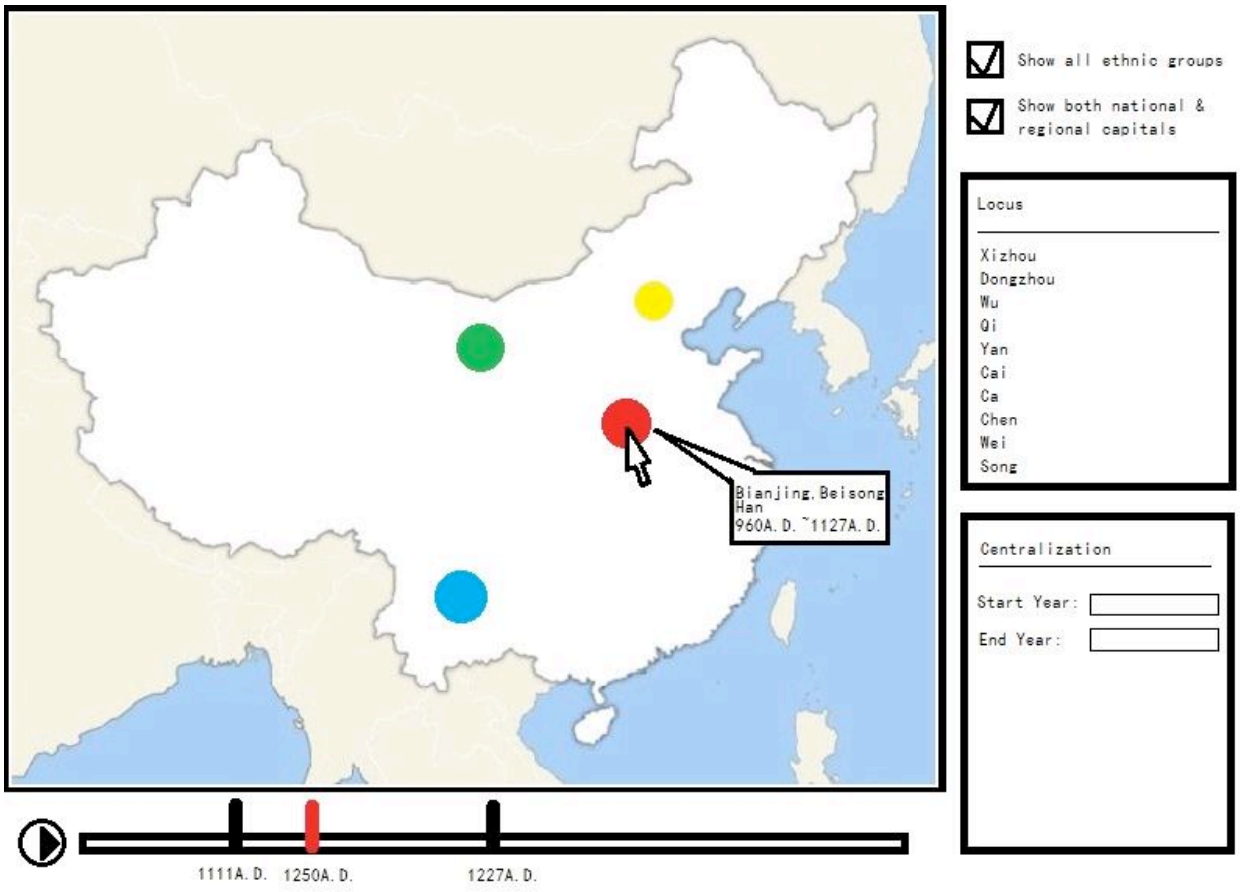
After start the application, a large map of China pops out in his eye. By moving the pointer on the time slide to the year 1111 A.D., he is able to see the locations of the capitals at that time: Dongjing, Shangjing, Xingqing, the capital of Beisong, Daliao and Daxia Kingdom, respectively. After setting the second pointer to the year 1280 A.D. and clicking the Play button, animation starts displaying how the locations of above capitals move and when new kingdoms like Nansong, Dajin and Damnegguguo appears. By enabling the relationship function, information regarding to which kingdom conquer which one else is displayed.

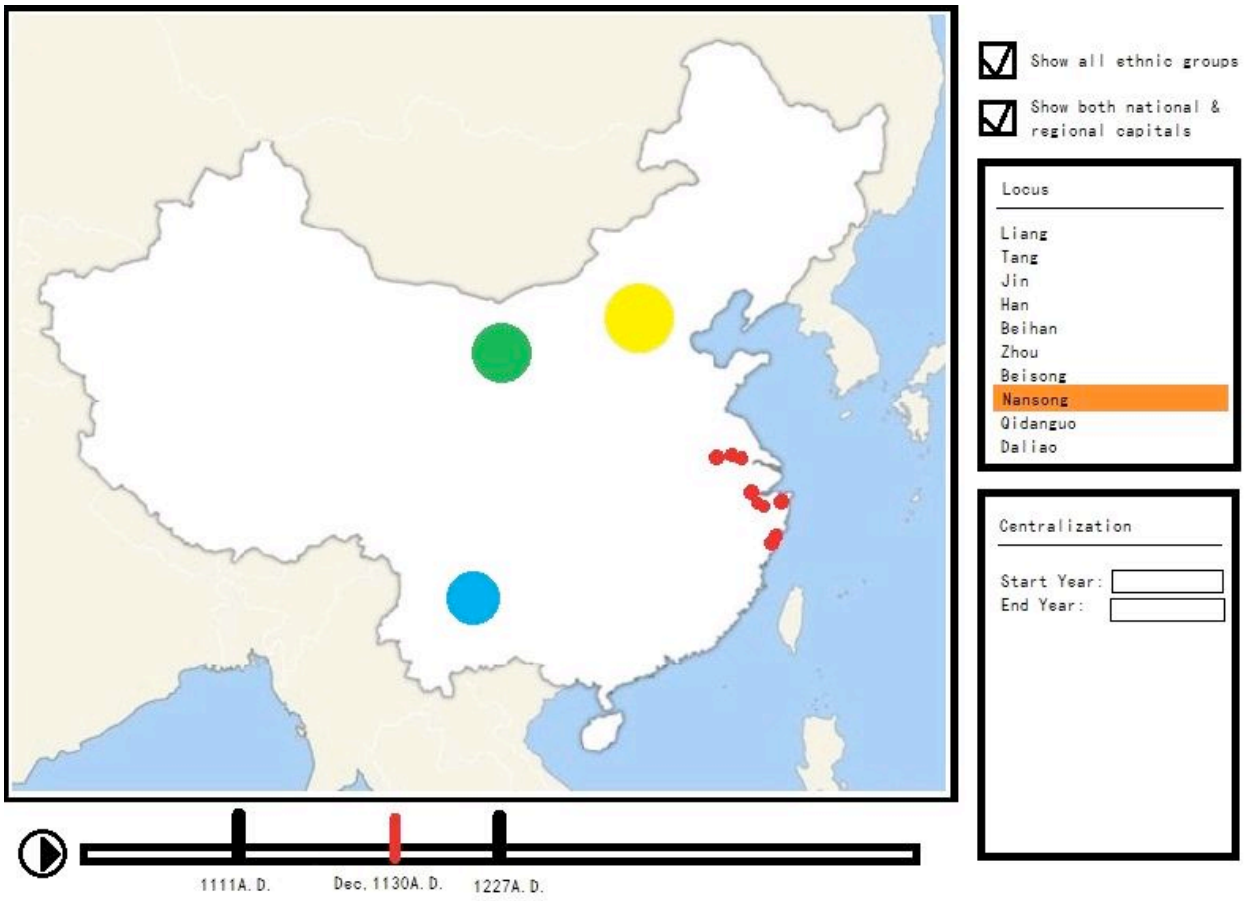
When the animation pointer directs to the year 1127 A.D., Allen noticed that the pointer starts moving slowly and now all the information on the map changes by month instead of by year. During the following 3 year, Allen clearly sees how the capital of Nansong moves from one place to another by keeping the previous location of the capital visible. After the kingdom is conquered, he still expresses great interests on the locus of the Nansong's capital. He then selects "Nansong" in the locus panel and the locus of the capital is displayed, starting from the year 1127 A.D. to 1179 A.D., when it is replaced by Damengguguo.

Considering the fact that so many countries appeared in the period (1111 A.D. to 1280 A.D.) above, Allen is eager to see how the political pattern is this period looks like. He then selects the "Centralization" panel and selects the start year and end year, a contour map with

different color representing different levels of centralization is displayed. By comparing the contour map during the above time period with the one during 1280 A.D. and 1840 A.D., Allen is satisfied with the strong visual differences, which he tries to link to the economical differences of two periods in north China.

5. Illustrations of the interface





6. Implementation approach

Based on one of the basic requirements that the system can be reached by general public, it is obvious that the system deployed will be web-based, which significantly narrows down our possible implementation solution options. After looking through the infovis resource list, and taking consideration of other factors such as: does this tool supports large set of functions, is it built recently so that some of the up-to-date visualization features are incorporated, does the tool require less cognitive load so that we can have a quick pick-up, and is the tool able to accelerate development regarding to the level of ease of engineering.

Based on above analysis, currently at least, we choose D3 as our candidate toolkit. In that case we will use mainly JavaScript as our programming language. While D3 provides basic modules that represent different types of data organization and fundamental ways of data manipulation, our job focuses on how to choose appropriate components so that different parts of the system can be combined and communicated. Due to the fact that both developing and deploying of web-based applications tends to perform well in the sense of cross-platform, no strict requirements of platforms exist. Comparing our own developing experience and preference, Windows platform will be used.

7. Milestones and schedule.

Oct, 28 Project proposal due
Nov,11 Getting familiar with toolkit, detailed design of visual encoding and way of interaction due
Nov, 18 System architecture due
Dec, 02 Implementation due
Dec, 09 Evaluation due
Dec, 11 Final report draft due
Dec, 12 Presentation slides due
Dec, 14 Final report due

8. Previous work.

Several areas of academic work related to our project have been done in an in-depth way. Previous exploration can be categorized into these 3 groups: historical data visualization, time-varying data visualization and geo-visualization. What we can learn from previous work are the answers to the following questions "How to visualize historical data?", "Are there any methods that can convey time-varying data in an effective way?" and "Any tips that we may need to pay attention to?"
History visualization, in itself, is pretty straight forward if only time-varying panel is provided. Thus, not much research-relative work have been done concerning to fair history event data. There are only some visualizations on how a product come into being, showing the whole process of forming an entity, such as Gamps[2] and software[3]. The common ground for all these work are they are focusing on the changes of the main body, while we are aiming at the pattern analysis when kingdoms replace and alternate each other. When drawing the entire overview, we might grab some ideas from History Flow[4].

Time-varying visualization expands several fields of research. They are trying to improve the performance when rendering huge data[5], or how to generate high dimension rendering for time-varying data[6]. Building a track[7] could help user to see the change even in a static view. Gapminder[8] is a good example for us to learn, since it has clear data in one view and not many fantastic animations are shown, which is similar to our project. What is really interesting is its way of bring us some information. Only by seeing those points changing location, we can figure out some meaningful phenomenon.

Geographical visualization is also an interesting field to explore. It is not quite the same as info-vis, however we need to check out some previous work to see how to build a good map with information we want to transfer. GeoVISTA[9] gives us inspiration on designing a good interface for geo-relative visualization. We are trying to achieve the effect by referring to the style of GeoVISTA, however the toolkit it provide will not be directly used.

Reference

[1]. http://zh.wikipedia.org/wiki/%E4%B8%AD%E5%9B%BD%E9%A6%96%E9%83%BD

[2]. http://gramps-project.org/2011/01/visualization/

[3]. http://www.youtube.com/watch?v=Tl1a2VN_pec

[4]. http://www.research.ibm.com/visual/projects/history_flow/

[5]. A Parallel Approach for Efficiently Visualizing Extremely Large, Time-Varying Datasets, by James Ahrens

[6]. High Dimensional Direct Rendering of Time-Varying Volumetric Data, by Jonathan Lee Woodring, B.S.

[7]. Illustration-inspired techniques for visualizing time-varying data, by Alark Joshi

[8]. http://www.gapminder.org/

[9]. http://www.geovista.psu.edu/software/